AD-A123 856 A SURVEY OF HELICOPTER AND AMBIENT URBAN NOISE LEVELS 1/1
IN PHOENIX ARIZONA(U) FEDERAL AVIATION ADMINISTRATION
WASHINGTON DC OFFICE OF ENVIRONMENT AND ENERGY
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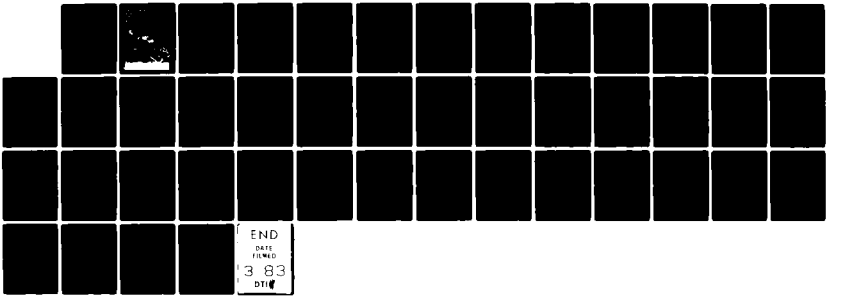

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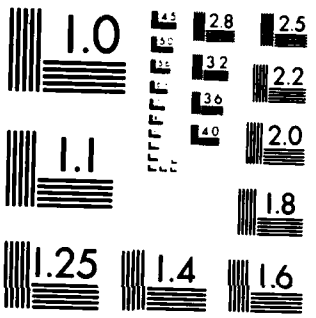

A Survey of Helicopter and Ambient Urban Noise Levels in Phoenix, Arizona

by
J. Steven Newman

December 1982
Final Report

U.S. Department of Transportation
Federal Aviation Administration
Office of Environment and Energy
Washington, D.C. 20591

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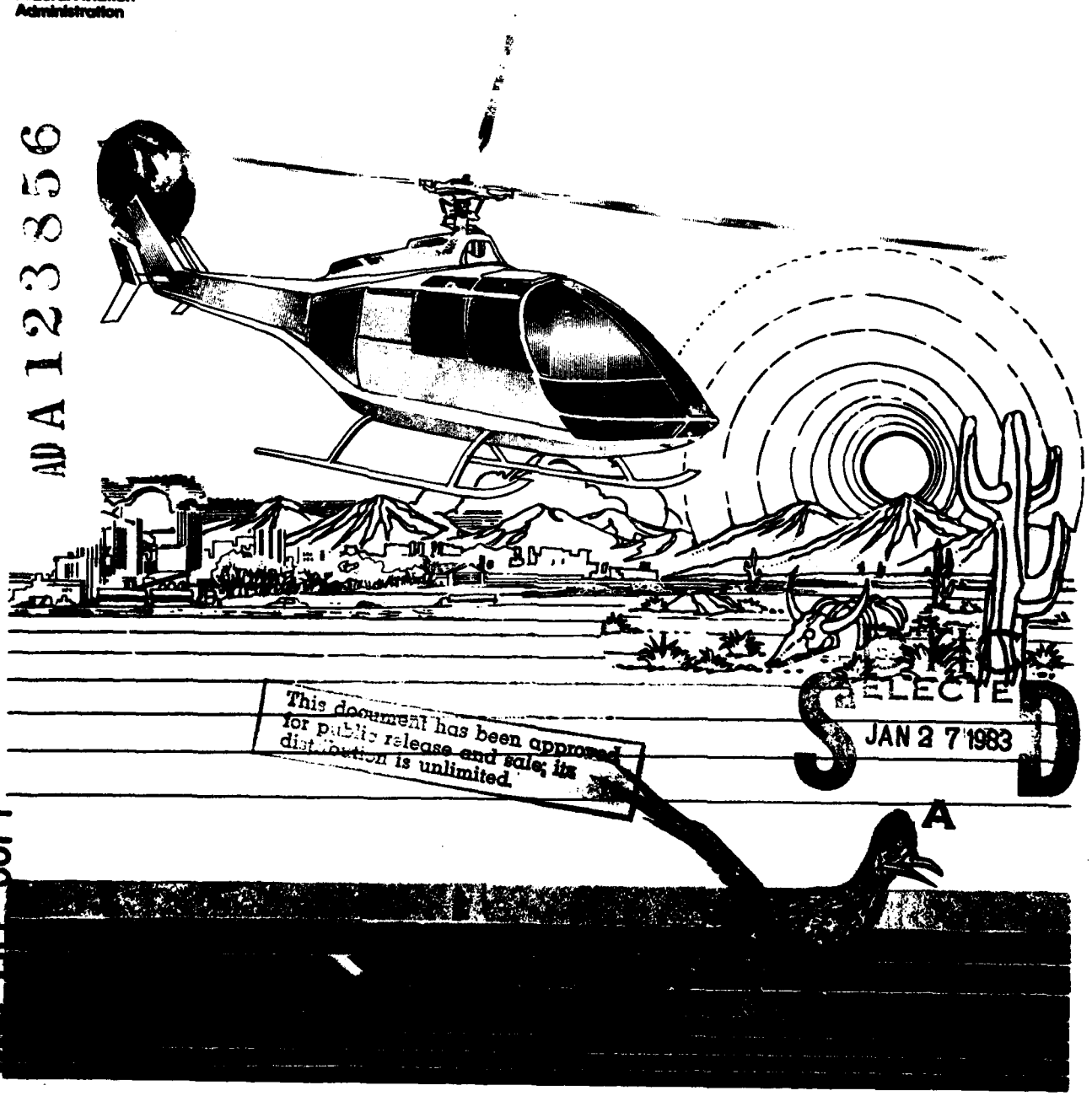

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16. Abstract

The FAA has been conducting controlled helicopter noise measurement programs since 1976. The data have been used for a variety of purposes including evaluation of proposed U.S. and international noise standards, validation of helicopter noise prediction methodologies, and development of practical heliport design guidance.

In order to supplement the results of the controlled tests, field survey data are also being gathered to represent in-service operating conditions. Measurements are intended to represent helicopter noise within the context of urban ambient background noise. The results reported in this document are termed "survey measurements", as opposed to controlled test data, in order to reflect the limited control imposed over factors which contribute to the variability of measured noise levels.

Noise data are presented for the Bell 206-L, Aerospatiale Alouette III, and the Aerospatiale A-Stare, SA-350. Operational modes include approach, takeoff, hover, and flat-pitch-idle. Noise data include A-Weighted Sound Level time histories, maximum A-Weighted Sound Level (L_{ASm}), Sound Exposure Level (L_{AE}), and Equivalent Sound Level (Leq).

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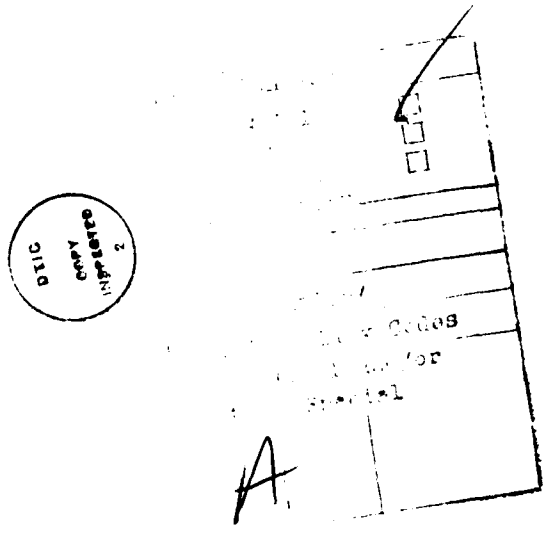

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A special thanks is extended to the following key participants:

Lt. Ron Shakleford	Arizona Department of Public Safety
Mr. Larry Cooper	Air-Evac
Mr. Bud Lake and Mr. Junior Johnson	Survival Flight

1.0 Noise Survey Objectives/Background - The FAA has been conducting controlled helicopter noise measurement programs since 1976. The data have been used for a variety of purposes including evaluation of proposed U.S. and international noise standards, validation of helicopter noise prediction methodologies, and development of heliport design guidance.

In order to supplement the results of the controlled tests, field survey data are being gathered to represent in-service operating conditions. Measurements are intended to represent helicopter noise within the context of urban ambient background noise. The results reported in this document are termed "survey measurements" as opposed to controlled test data in order to reflect the limited control imposed over factors which contribute to the variability of measured noise levels. These factors include: 1) the presence of reflective surfaces (automobiles, buildings, people); 2) the influence of ambient noise on signal-to-noise ratio; 3) the presence of non-homogeneous ground surface characteristics (grass, concrete, asphalt, shrubbery); 4) the absence of control or documentation of helicopter performance characteristics (rotor RPM, torque, airspeed, acceleration); 5) the absence of helicopter position data (photo-scaling, theodolite or laser tracking). The effect of those factors mentioned above is to decrease the repeatability between successive measurements. Nonetheless survey data (in quantity) very effectively establish whether or not controlled data are representative of typical operating conditions.

Phoenix was selected as a study site because of the availability of heli stops in close proximity to residential areas and the extremely cooperative helicopter operators and hospital administrators who had previously supported tests conducted by the City of Phoenix Planning Department.

2.0 Test Participants

2.1 Noise Test Field Team - The noise survey was conducted by personnel from the FAA headquarters, Office of Environment and Energy, Noise Abatement Division, AEE-100, Washington, D.C. 20591.

The field team consisted of the following individuals:

1. J. Steven Newman (AEE-100)
2. Sharon A. Daboin (AEE-100)
3. Neal Phillips (AMA-4)
4. Steven Albersheim (AEE-100)

2.2 Helistops

St. Luke Hospital
525 N. 18th Street
Phoenix, Arizona

Doctors Hospital
20th Street and Thomas
Phoenix, Arizona

2.3 Planning and Background Support (not official participants but of great assistance in providing background information)

City of Phonenix Planning Department
Chris Cusick
251 West Washington
Phoenix, Arizona 85003

2.4 Test Helicopters/Operators

1. Arizona Department of Public Safety
   Lt. Ron Shakleford
   Bell 206-L
2. Air-Evac
   Mr. Larry Cooper
   Aerospatial SA-350 A-Star
3. Survival Flight
   Mr. Bud Lake
   Aerospatial Allouette III

3.0 Noise Measurement Locations - Figure 1 provides a map of FAA approved helistops in Phoenix. The noise survey was conducted at locations 10 (St. Luke) and 16 (Doctors).

3.1 St. Luke Hospital (see Figure 2) - The measurement sites were established on a line extending southward from the helipad along a three foot wide grass parkway between the hospital parking lot and 19th Street. Duplex single story residential dwellings line the other side of 19th Street.

3.2 Doctors Hospital (see Figure 3) - The measurement sites were established along a line extending southeast from the center of the helipad across a cement parking lot beyond a short (4 ft) wall, and across a quiet residential street to the grass-dirt parkway in front of a single family detached dwelling.

FAA APPROVED HELISTOPS IN PHOENIX

1. KOOL TV, 511 W. Adams
2. KPNX TV, 1101 N. Central Avenue
3. Phoenix Baptist Hospital, 6025 N. 20 Av.
4. Ghila Port, 410 S. 59th Avenue
5. John C. Lincoln Hospital, 9211 N. 2 St.
6. Good Samaritan Hospital, 5102 W. Campbell
7. Memorial Hospital, 1201 S. 7th Avenue
8. St. Joseph Hospital, 350 W. Thomas Road
9. Maricopa County General Hospital, 2601 E. Roosevelt
10. St. Luke Hospital, 525 N. 18th Street
11. Phoenix Police Dept., Washington & 5 Av.
12. Westcor, Tatum & Cactus
13. KTVK TV, 16th Street and Osborn
14. First National Bank, Washington & 2nd Av.
15. Good Samaritan Hospital, 12 St. & Willetta
16. Doctors Hospital, 20 Street & Thomas
17. Knoell Brothers, 2401 S. 24th Street

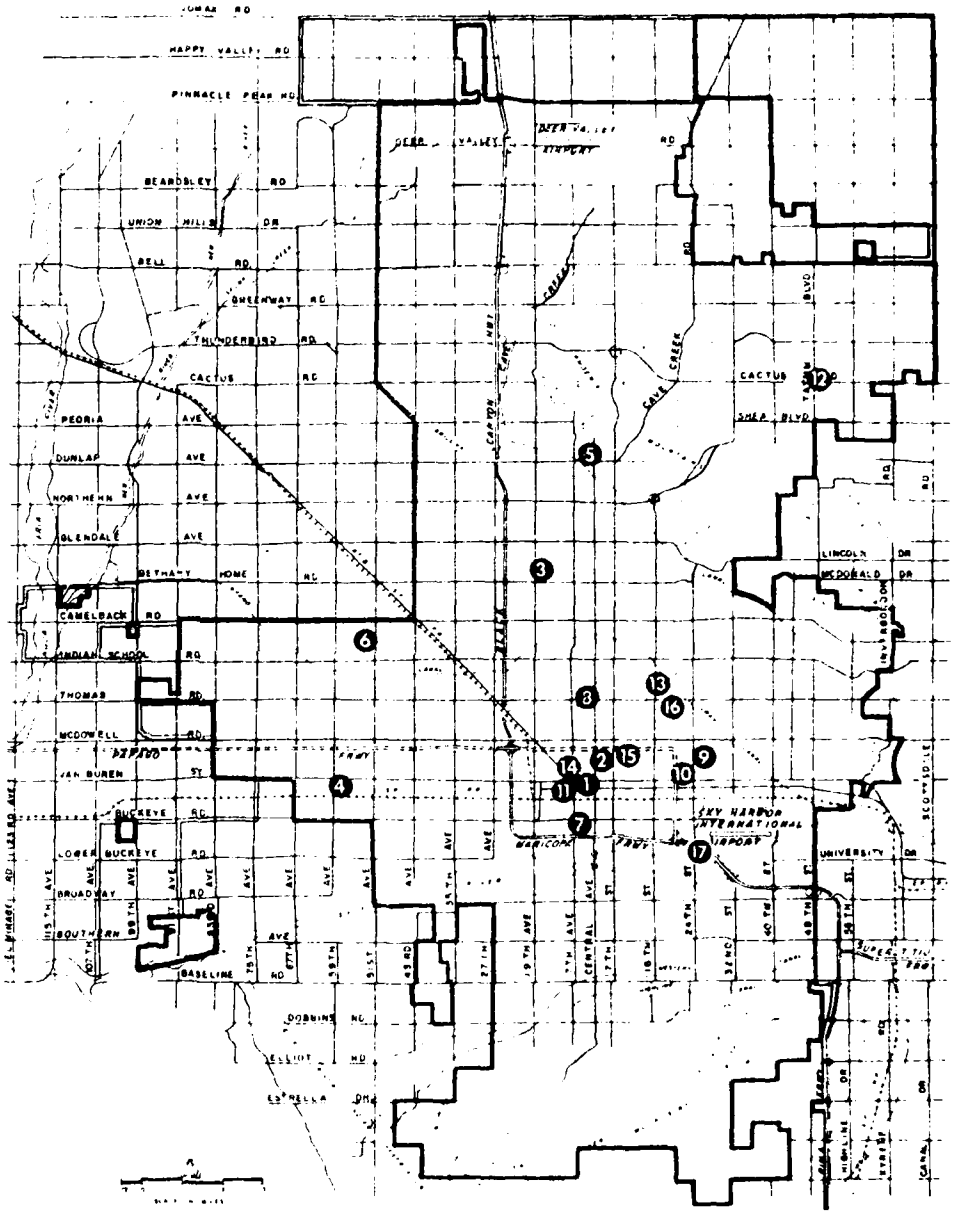


Figure 1

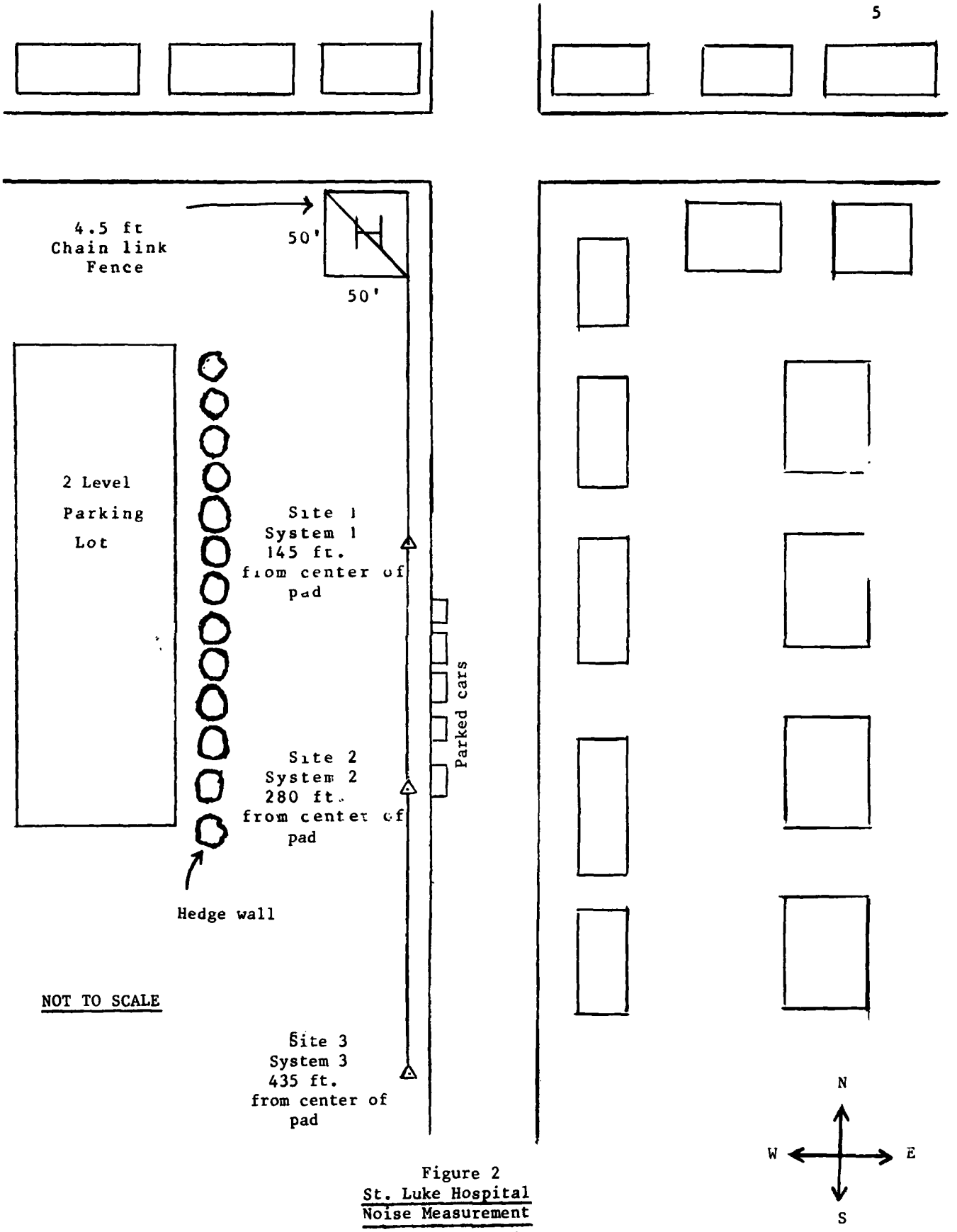


Figure 2
St. Luke Hospital
Noise Measurement
Site Schematic

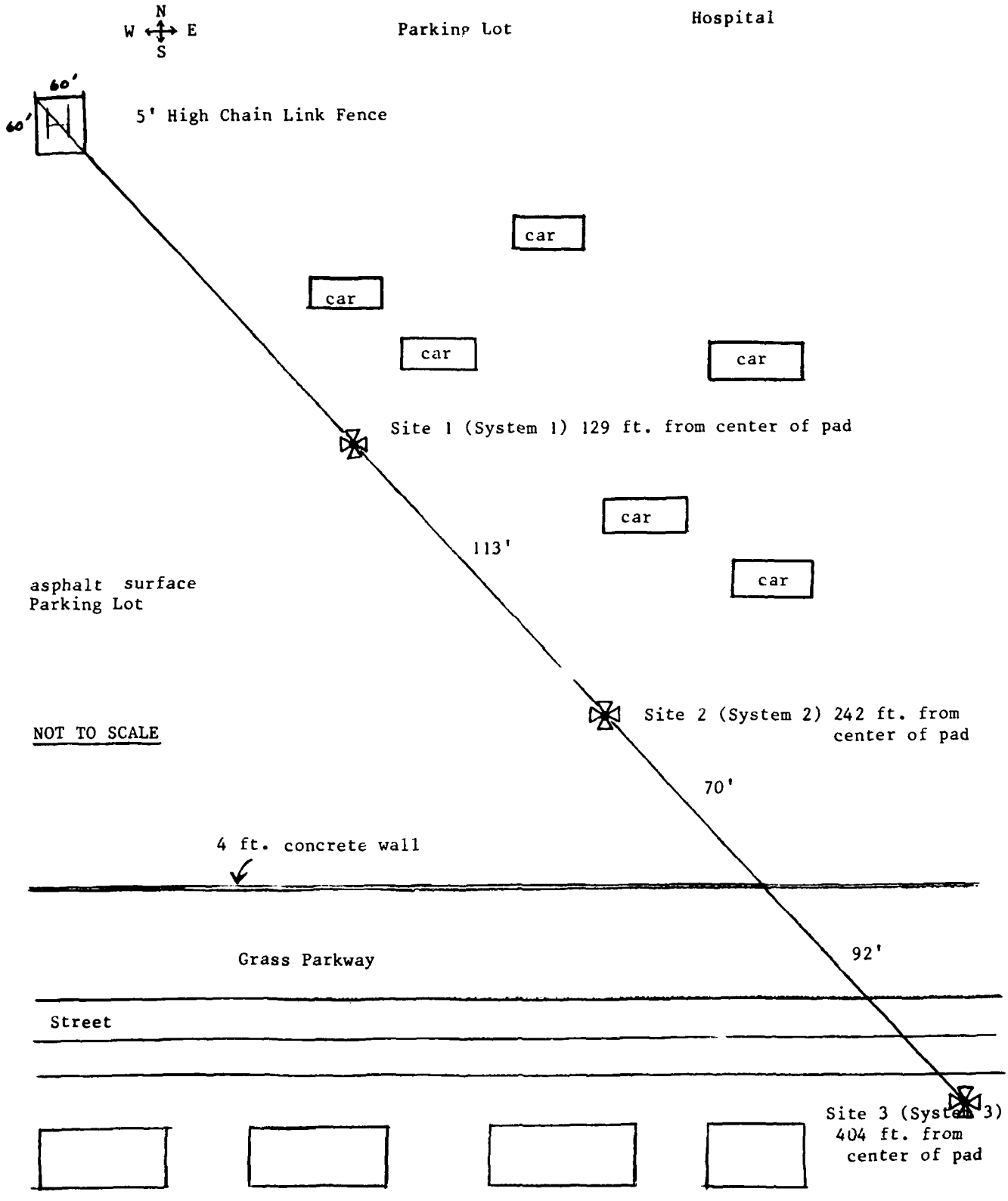


Figure 3
Doctors Hospital
Noise Measurement
Site Schematic

4.0 Test Helicopters/Description

1. Bell 206 - The Arizona Department of Public Safety (DPS) Bell 206L used in the test is powered by a single Detroit-Diesel Allison C-20B engine generating 425 shaft horsepower (SHP). This is one of the early Bell 206 models.

Generalized physical and performance characteristics for more recent (although very similiar) Bell 206L models are presented below for sea level (SL) conditions.

	Bell 206L
Manufacturer	Bell
Country	USA
Model	206
Engine(s) (Number and Type)	1, Allison C-20B
Max Takeoff Weight	3200 lbs
Shaft Horsepower (SHP)	400
Rotor Speed	394 RPM, 100%
Rotor Diameter	Main 33 ft; 4 in/Tail 5 ft. 2 in
Number of Blades	Main 2/Tail 2
Best Rate of Climb	1260 feet per minute
Speed for Best Rate of Climb	52 kts
Max Cruise Speed	130 kts (SL)

2. Aerospatiale Alouette III - The 4,960 lb Survival Flight, Aerospatiale Alouette III is powered by a single 570 Shaft Horsepower (SHP) Turbomeca Artouste IIIB engine. Additional performance and physical characteristics are provided below for sea level (SL) conditions.

Alouette III

Manufacturer	Aerospatiale
Country	France
Model	Alouette III
Engine(s) (Number & Type)	1, Turbomeca Artouste IIIB
Max Takeoff Weight	4,960 lbs
Shaft Horsepower (SHP)	570 SHP
Rotor Speed	Main, 353 RPM/Tail, 2001 RPM
Rotor Diameter	Main, 36 ft; 1.75 in/Tail, 6 ft. 3.25 in
Number of Blades	Main, 3/Tail, 2
Best Rate of Climb (SL)	850 ft./min
Speed for Best Rate of Climb	70 kts
Max Cruise Speed	100 kts (SL)

3. Aerospatiale AS-350 A-STAR - The 4,200 lbs class A-STAR operated by Air-Evac is powered by a single 641 SHP Turbomeca Arriel engine. The A-STAR was developed as a successor to the Alouette III. Additional performance and physical characteristics are provided below for sea level conditions.

AS-350 A-STAR

Manufacturer	Aerospatiale
Country	France
Model	AS-350
Engine(s)(Number and type)	1, Turbomeca Arriel
Max Takeoff Weight	4,200 lbs
Shaft Horsepower (SHP)	641
Rotor Speed	Main, 366 RPM
Rotor Diameter	Main, 35 ft, .75 in/Tail, 6 ft, 1.25 in
Number of Blades	Main, 3/Tail, 2
Best Rate of Climb	1760 ft./min., 1575 ft./min. vertical
Speed for Best Rate of Climb	70 kts
Max Cruise Speed	125 kt.

5.0 Helicopter Operational Procedures - The helicopter operational procedures requested in the test were designed to most efficiently acquire takeoff, approach, hover and ground idle acoustical data with a limited number of measurement personnel. This imposed the requirement that the helicopter approach from a given direction, over the measurement array, then "re-trace its steps" departing in the direction from which it came, again passing over the measurement array. This operation necessitated very low wind conditions (which fortunately were realized), as any significant tail-wind component would have prevented takeoffs with the wind. The operational instructions conveyed to the pilots are set out below.

St. Luke Hospital

1. Circle the area to become oriented and alert measurement personnel to prepare for data acquisition.
2. Approach northbound along 19th Street on a "normal" descent path into the heli-pad.
3. Set the skids down along the same heading as the approach and achieve a flat-pitch, idle-thrust configuration for a period of 2-3 minutes.
4. On signal from the ground coordinator add power and achieve hover-in-ground-effect approximately 5 feet above the pad and rotate 90° then lower back onto the pad, and once again achieve a flat-pitch idle-thrust configuration. (NOTE: In one case, the 206-L rotated 180°)
5. After 2-3 minutes the ground coordinator will signal for a "normal" departure to the south passing over the measurement array.

Doctors Hospital - The operations at Doctors Hospital were identical to those at St. Luke with the exception that landing approaches were executed from the southeast and takeoffs were conducted toward the southeast.

6.0 Noise Measurement Equipment -- Three noise measurement systems were used during the test. Each of the first two systems consisted of a GenRad 1988 Precision Integrating Sound Level Meter (PISLM) with DC output to a Metrosonics 404 Graphic Level Recorder (GLR). The GLR operated at a paper transport speed of 12 seconds per centimeter (500 cm/hr). System 3 consisted of a GenRad 1945 Community Noise Analyzer (CNA). Each system powered a P-42 (or equivalent) microphone preamplifier driving a GenRad, 1/2 electret microphone. The microphone-preamplifier assembly was mounted four feet above ground level with the microphone oriented for grazing incidence. Figure 4 provides a schematic of the noise measurement systems. Each instrument was calibrated before and after each survey measurement period. The electrical noise floor of each system was also documented.

ACOUSTICAL MEASUREMENT INSTRUMENTATION

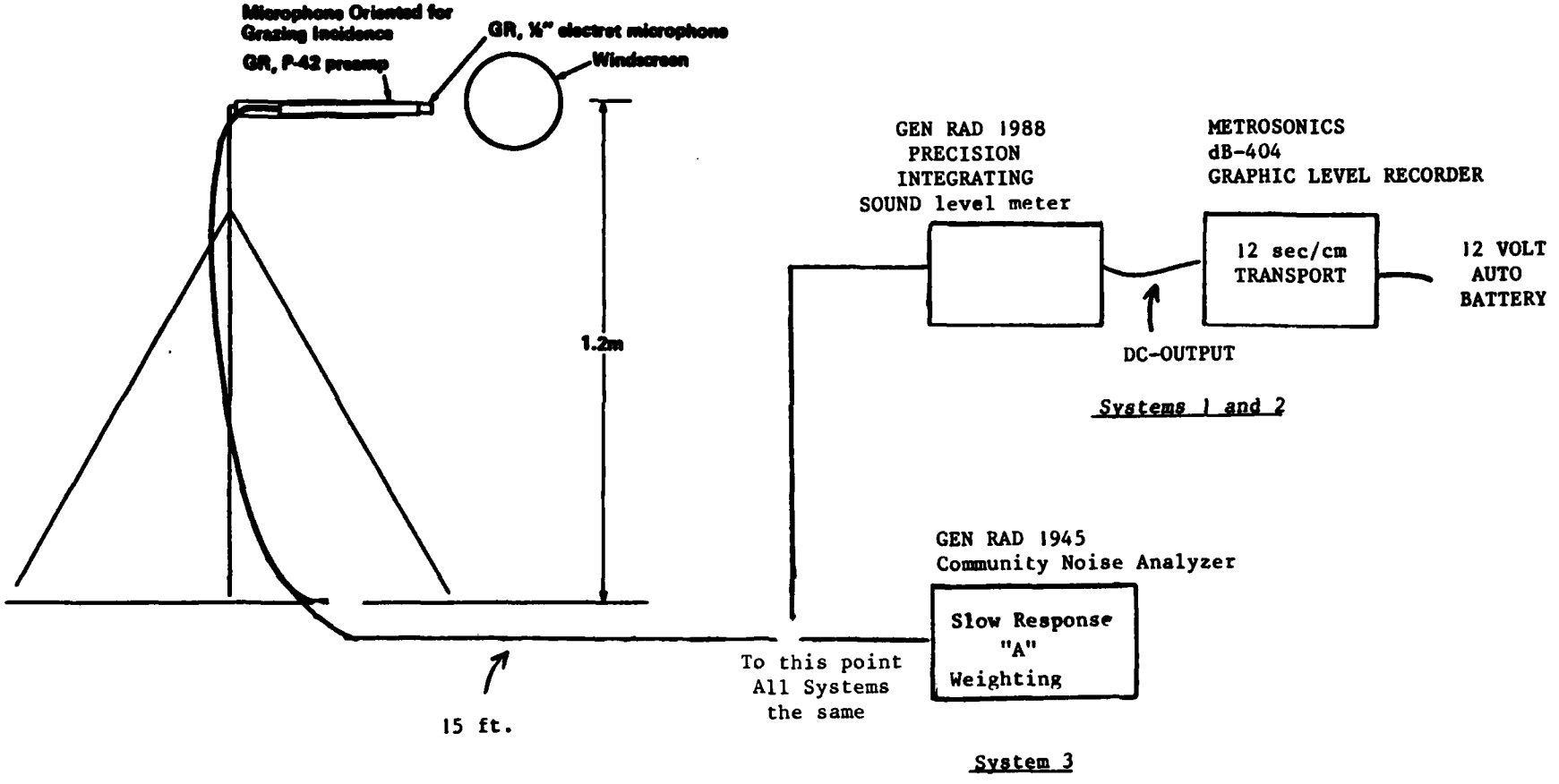


Figure 4
Noise Measurement Systems

7.0 Noise Data Acquisition/Acoustical Metrics - Systems 1 and 2 collected single event data consisting of the maximum A-weighted sound level (L_{AS}), Sound Exposure Level (L_{AE}), integration time and Equivalent Sound Level (Leq) obtained using the GenRad 1988 PISLM, with "slow" meter response. The L_{AS} output of the GenRad 1988 was plotted graphically using a time base of 12 sec per centimeter. System 3 collected a statistical profile of ambient noise using the GenRad 1945 Community Noise Analyzer. Data output included:

L_{ASm} - Maximum A-weighted sound level reached during the sample period.

L_{XX} - The dB(A) noise level which was exceeded XX% of the time during the sample period.

L_{ASmin} - Minimum A-weighted sound level recorded during the sample period.

L_{eq} - The equivalent sound level for the sample period.

System 3 was also used to acquire the L_{ASm} for transient background noise events as well as helicopter operations.

8.0 Typical Noise Levels in an Urban Environment - The table, provided below, is a guide to noise levels typically encountered in an urban environment. Examination of this table will provide the reader with orientation useful in better understanding the meaning of L_{ASm} values.

Noise Levels Typically Encountered in an Urban Environment

Source	L_{ASm}
Rustling leaves	20
Room in a quiet dwelling at midnight	32
Soft whispers at 5 feet	34
Men's clothing department of large store	53
Window air conditioner	55
Conversational speech	60
Household department of large store	62
Busy restaurant	65
Typing pool (9 typewriters in use)	65
Vacuum cleaner in private residence (at 10 feet)	69
Ringing alarm clock (at 2 feet)	80
Loudly reproduced orchestral music in large room	82
Printing press plant (medium size automatic)	86
Heavy city traffic	92
Heavy diesel-propelled vehicle (about 25 feet away)	92
Air grinder	95
Cut-off saw	97
Home lawnmower	98
Turbine condenser	98
150 cubic foot air compressor	100
Banging of steel plate	104
Air hammer	107
Jet airliner (500 feet overhead)	115

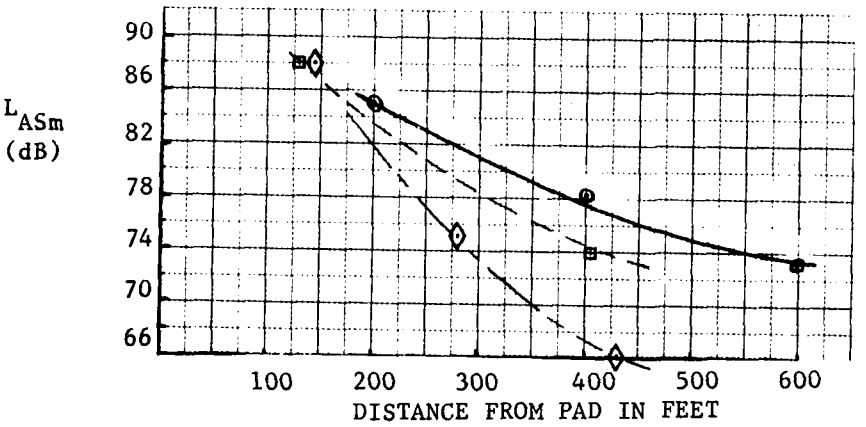
9.0 Data Presentation - Noise measurement data are presented in the appendices of this report organized by helicopter mode. There are two sets of data for each helicopter model; one set for each day of testing. Ambient noise data acquired by System 3 (GenRad 1945 CNA) may be applicable in several cases where ambient alone is compared with ambient-plus-helicopter "A", then again with ambient-plus-helicopter "B", tested during the same measurement session. In order to create a "stand alone" analysis for each helicopter model, it is necessary for certain tables to appear more than once. In addition to single event helicopter data and ambient statistical data, a limited amount of ambient transient event, maximum noise level information is provided along with the Bell 206-L data in Appendix A.

In certain cases high levels of ambient noise or measurement equipment difficulties prevented accurate recording of helicopter noise data. In such cases dashs are entered in the data tables. As system 3 does not have an L_{AE} computational capability dashs are entered in the data tables.

10. Data Discussion/Application - The Alouette III and A-Star are welcome new additions to the FAA helicopter data base. While the approach and takeoff data are survey quality (see Section 1.0), the flat-pitch, idle thrust Leq data provide good statistical estimates of the average L_{AS} for the idle operation. Test results also include excellent idle-mode and hover-in-ground-effect (HIGE) data for the Bell 206-L. The HIGE data are compared below with data derived from a 1976 FAA test

Hover-In-Ground-Effect Comparison

DISTANCE(ft)	L_{ASm}(dB) 1976 FAA Test	DISTANCE(ft)	L_{ASm}(dB) DRS. HOSP.	DISTANCE(ft)	L_{ASm}(dB) ST. LUKE HOSP
200	85.0 ⊙	129	88 ⊡	145	88 ◈
400	78.2 ⊙	242		280	75 ◈
600	73.5 ⊙	404	74 ⊡	430	66 ◈



BELL-206L
HOVER-IN-GROUND-EFFECT
SOUND LEVEL versus
DISTANCE

A comparison of a noise-distance relationssip derived from previously attained FAA (1976) shows reasonable agreement, especially at a distance of 200 ft. However, the divergence of data points at greater distances suggests that excess ground attenuation influences in reality may exceed those values used in the extrapolation of the 1976 data. While the limited sample size precludes making any strong statistical statement with respect to excess ground attenuation, the acquisition

of additional data will permit further evaluation.

Comparison of HIGE and Idle mode noise data suggests a 12 to 15 decibel difference for both the 206-L and A-Star. The Alouette III displays a smaller (approx. 8 dB) difference between HIGE and Idle modes.

Consistent with the HIGE-Idle similarities observed for the 206-L and A-Star we note similarities also in the absolute noise levels with the A-Star slightly lower than the 206-L. The Alouette levels appear approximately 5 to 7 dB higher.

Examination of the System 3, GenRad 1945, statistical data provides some interesting insights. The increase in 30-minute Leq associated with a single helicopter landing-takeoff cycle is on the order of 8 to 15 decibels, a tremendous change in cumulative noise exposure. When this single operational cycle is considered for a sampling period of one hour the increase is still very large, 5-12 dB. The inference which can be drawn from these data is that the imposition of one operational cycle per hour can result in a very large increase in Leq for a 24-hour period of operation.

While our measurement sites are within approximately 400 feet of the helipad it is worth noting that so are many residential dwellings. It would have been most helpful to supplement our statistical measurements along the ingress-egress route with measurements off-track. The off-track Leq data would indicate whether those areas sustain even a fraction of the impact associated with on-track locations.

It is emphasized that the discussion in the preceeding paragraph refers to a hypothetical scenario involving one-per-hour operations and in no way reflects operations in Phoenix.

Appendix A: Bell 206-L

Doctors Hospital

Table A1: Presents single-event helicopter data

Table A2: Displays the influence of a Bell 206-L operation cycle on ambient maximum sound levels

Table A3: Provides a comparison of helicopter and ambient maximum sound levels

Figure A1: Provides a noise level time-history of the helicopter operation cycle.

St. Luke Hospital

Table A4: Presents single-event helicopter data

Table A5: Provides a comparison of helicopter and ambient maximum sound levels

Figure A2: Provides a noise level time-history of the helicopter operation cycle

NOTE: Due to high ambient noise levels (blow-in insulation operation at a nearby home) it was not possible to assess the impact of 206-L levels on the ambient at St. Luke.

TABLE A1

FAA HELICOPTER NOISE SURVEY

Helicopter: Bell 206-L Test Date: 8/12/82

Location: Doctors Hospital

Test Time: 1:00 pm MST MET: 89°F, 59% RH

Site	Distance from Center of Pad	Approach Noise Units are Decibels (db)		Takeoff Noise Units are Decibels (db)		Decibels (dB)		
		L_{AE}	L_{ASm}	L_{AE}	L_{ASm}	L_{Aeq} I_1	L_{ASm} HIGE	L_{Aeq} I_2
1	129 ft	-	96	101.7	92.8	75.1	89	76.4
2	242 ft	-	-	-	-	-	-	-
3	404 ft		92		87	60	74	71

NOTE:

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow-Response maximum Sound Level

I_1: Idle mode 1, fuselage parallel to measurement array (tail toward array)

I_2: Idle mode 2, fuselage parallel to measurement array (nose toward array)

HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted Equivalent Sound Level

TABLE A2

INFLUENCE OF HELICOPTER OPERATIONS ON AMBIENT SOUND LEVELS

L(min)	48	44	45
L(99)	49	45	47
L(90)	52	51	51
L(50)	58	58	56
L(10)	69	79	64
L(1)	84	88	73
L(.1)	89	94	80
L(max)	90	95	81
L(EQ)	70	74	62
SAMPLE LENGTH	30 min	30 min	30 min
DATE	8/12/82	8/12/82	8/12/82
SAMPLE PERIOD	12:50-1:20 pm	1:20-1:50 pm	1:50-2:20 pm
NOISE SOURCES	AMBIENT + 206-L OPERATIONS	AMBIENT + ALOUETTE 3 OPERATIONS	AMBIENT
LOCATION	DOCTORS HOSPITAL Site 3, 404 Ft. from center of pad	SAME	SAME

COMMENT:

TABLE A3

COMPARISON OF AMBIENT AND HELICOPTER SLOW RESPONSE, A-WEIGHTED MAXIMUM SOUND LEVELS (L_{ASm})

Location: Site 3, Doctors Hospital Date: 8/12/82

Time: 1:30 pm Meas. Site Loc. Site 3 is 404 ft from the helipad center, approximately 300 ft from the intersection of 20th Street and Thomas

L_{ASm}	Noise Source Description and Distance	
92	Helicopter Approach over Site 3	
87	Helicopter Takeoff over Site 3	
60-70	Helicopter Idle on helipad	
74	Helicopter Hover on helipad	
77	Motorcycle	Background noise primarily traffic on 20th Street approximately 300 ft from Site 3.
63	Auto	
76	Auto	
79	Motorcycle	
78	Auto	
76	Auto	
71	Auto	
77	Medium Truck	
74	Pick-up	
76	Pick-up	
74	Auto	
73	Auto	

FIGURE A1

BELL 206-L/SITE 1
DOCTORS HOSPITAL/AUG 12, 1982

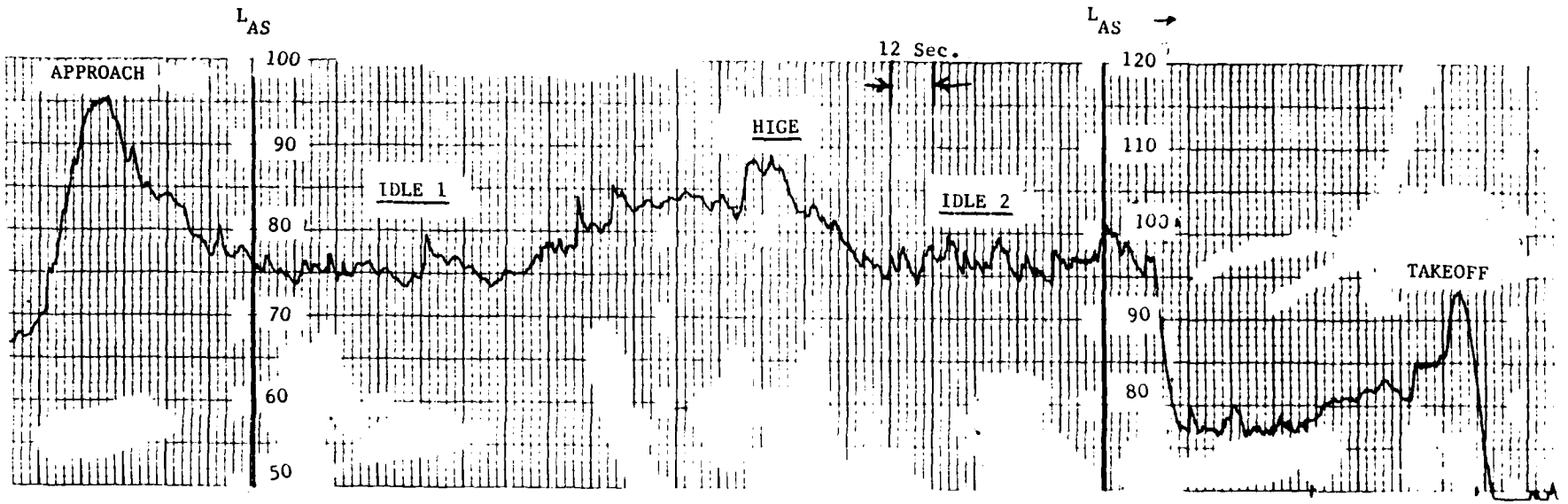


TABLE A4

FAA HELICOPTER NOISE SURVEY

Helicopter: Bell 206-L Test Date: 8/13/82

Location: St. Luke Hospital, Phoenix Arizona

Test Time: 9:00 am MST MET: 82°F, 72% RH

Site	Distance from Center of Pad	Approach Noise Units Are Decibels (dB) L_{AE}	L_{ASm}	Takeoff Decibels (dB) L_{AE}	L_{ASm}	Decibels (dB) L_{Aeq} I_1	L_{ASm} HIGE	L_{Aeq} I_2
1	145 ft	105.7	97.5	101.6	89.5	71.2	88	75.9
2	280 ft	101.6	93.1	96.2	86.2	62	75	66
3	435 ft	-	89	-	86	-	66	-

Comment: Approach angle approx. 10 degrees, near vertical ascent with transition to level flight 100 ft over Site 1.

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow-Response maximum Sound Level

I_1: Idle mode 1, fuselage parallel to measurement array (nose arway)

I_2: Idle mode 2, fuselage perpendicular to measurement array

HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted, Equivalent Sound Level

TABLE A5

COMPARISON OF AMBIENT AND HELICOPTER
SLOW RESPONSE, A-WEIGHTED MAXIMUM
SOUND LEVELS (L_{ASm})

Location: St. Luke Hospital Date: 8/13/82

Time: 10:24 am MST Meas. Site Loc. Site 2, 280 ft from center of helipad, across the street from residences

L_{ASm}	Noise Source Description and Distance
93.1	Helicopter Approach over Site 2
86.2	Helicopter Takeoff over Site 2
64	Helicopter Idle on helipad
75	Helicopter Hover on helipad
64	Car
62	Car
64	Car
74	Car
64	Car
63	Car
63	Van
64	Car
66	Car
67	Car
68	Car
63	Car
64	Car
65	Car
69	Van
72	Truck
71	Truck
59	insets buzzing (lowest ambient)
65	Car
65	Car
74	Truck
72	engine racing (parked car)

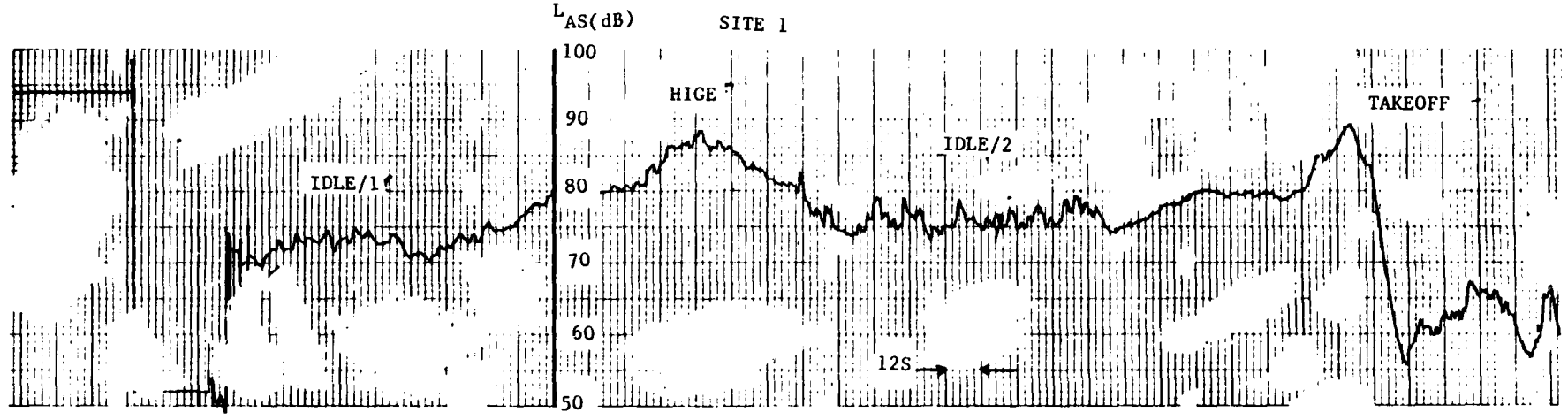
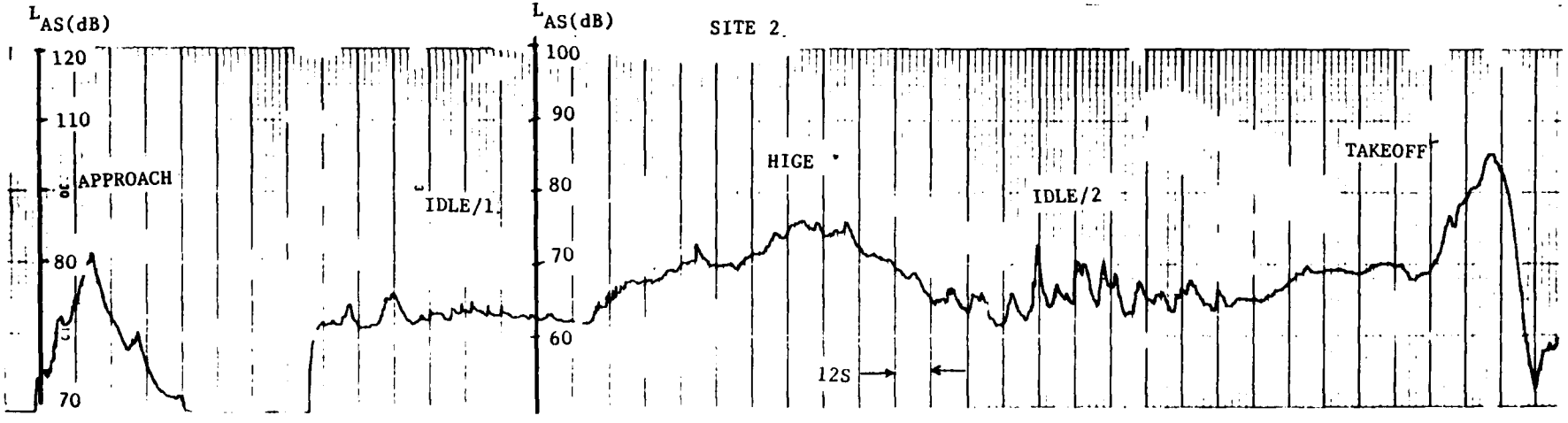


FIGURE A2

BELL 206-L/SITES 1 and 2
St. Luke Hospital/Aug 13, 1982



Appendix B: Alouette III

Doctors Hospital

Table B1: Presents single event helicopter data

Table B2: Displays the influence of an Alouette III operation cycle on ambient sound levels

Figure B1: Provides a noise level time-history of the helicopter operation cycle

St. Luke Hospital

Table B3: Presents single event helicopter data

Table B4: Displays the influence of a Bell 206-L operation cycle on ambient sould levels

Figure B2: Provides a noise level time-history of the helicopter operation cycle

TABLE B1

FAA HELICOPTER NOISE SURVEY

Helicopter: Alouette III Test Date: 8/12/82

Location: Doctors Hospital

Test Time: 1:30 pm MST Met: 89°F, 59% RH

Site	Distance from Center of Pad	Approach Noise Unites Are Decibels (dB) L_{AE}	L_{ASm}	Takeoff L_{AE}	L_{ASm}	Decibels dB L_{Aeq} I_1	L_{ASm} HIGE	L_{Aeq} I_2
1	129 ft	110.7	100.5	107.5	100.7	89.3	96	91.6
2	242 ft	-	-	-	-	-	-	-
3	404 ft	-	95	-	94	72	-	75

NOTES:

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow-Response maximum Sound Level

I_1: Idle mode 1, fuselage parallel to measurement array (nose pointing away)

I_2: Idle mode 2, fuselage perpendicular to measurement array

HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted Equivalent Sound Level

TABLE B2

INFLUENCE OF HELICOPTER OPERATIONS ON AMBIENT SOUND LEVELS

L(min)	48	44	45
L(99)	49	45	47
L(90)	52	51	51
L(50)	58	58	56
L(10)	69	79	64
L(1)	84	88	73
L(.1)	89	94	80
L(max)	90	95	81
L(EQ)	70	74	62
SAMPLE LENGTH	20 min	30 min	30 min
DATE	8/12/82	8/12/82	8/12/82
SAMPLE PERIOD	12:50-1:20 pm	1:20-1:50 pm	1:50-2:20 pm
NOISE SOURCES	AMBIENT + 206-L OPERATIONS	AMBIENT + ALOUETTE 3 OPERATIONS	AMBIENT
LOCATION	DOCTORS HOSPITAL SITE 3, 404 Ft. from center of pad	SAME	SAME
COMMENT			

FIGURE B1

ALOUETTE III/SITE 1
Doctors Hospital/Aug 12, 1982

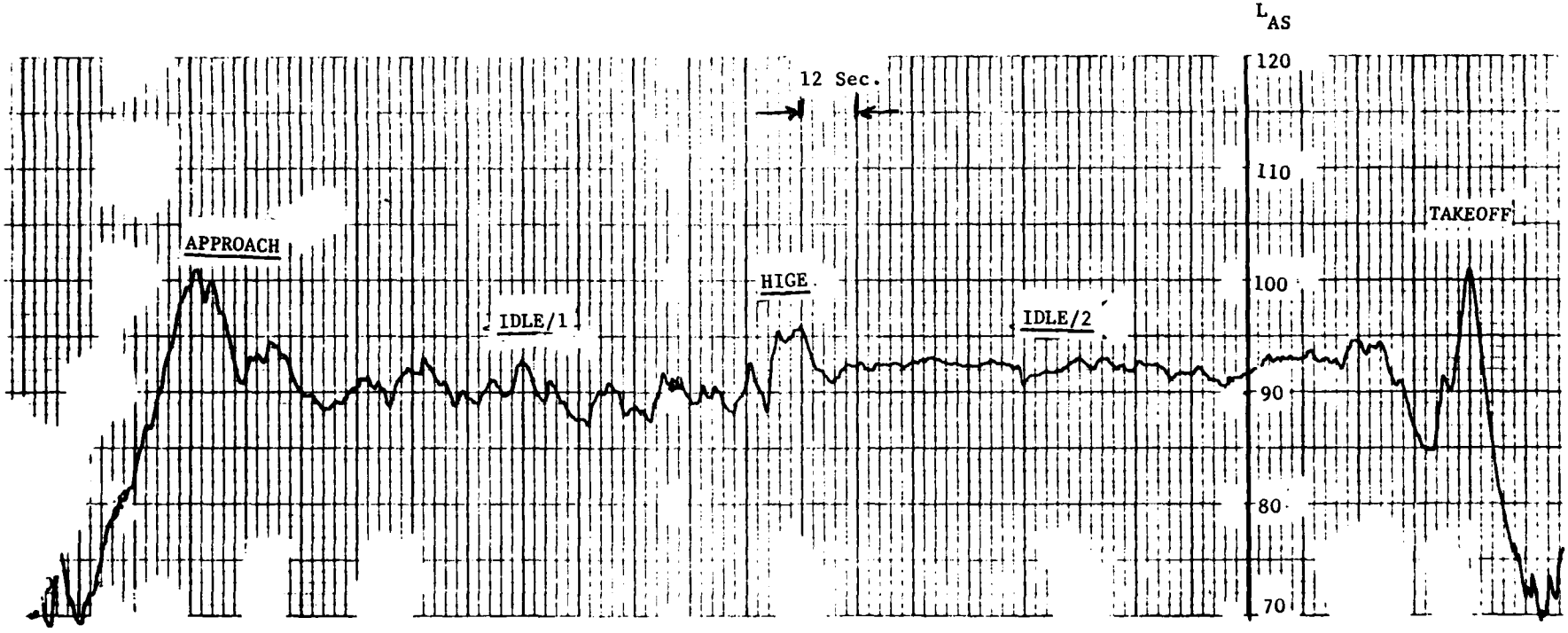


TABLE B3

FAA HELICOPTER NOISE SURVEY

Helicopter: Aerospatiale Alouette III Test Date: 8/13/82

Location: St. Luke Hospital, Phoenix Arizona

Test Time: 10:00 am MST MET: 82°F, 72% RH

Site	Distance from Center of Pad	Approach Noise Units Are Decibels (dB)		Takeoff Noise Units Are Decibels (dB)		Decibels dB		
		L_{AE}	L_{ASm}	L_{AE}	L_{ASm}	L_{Aeq} I_1	L_{ASm} HIGE	L_{Aeq} I_2
1	145 ft	-	104	105.3	97.4	86.4	93	86.5
2	280 ft	109.1	101	104.0	98.7	78.0	83	76.7
3	435 ft	Site eliminated due to high ambient noise						

Comment: Very slow long duration approach over measurement array.

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow Response maximum Sound Level

I_1: Idle mode 1 fuselage parallel to measurement array

I_2: Idle mode 2 fuselage perpendicular to measurement array

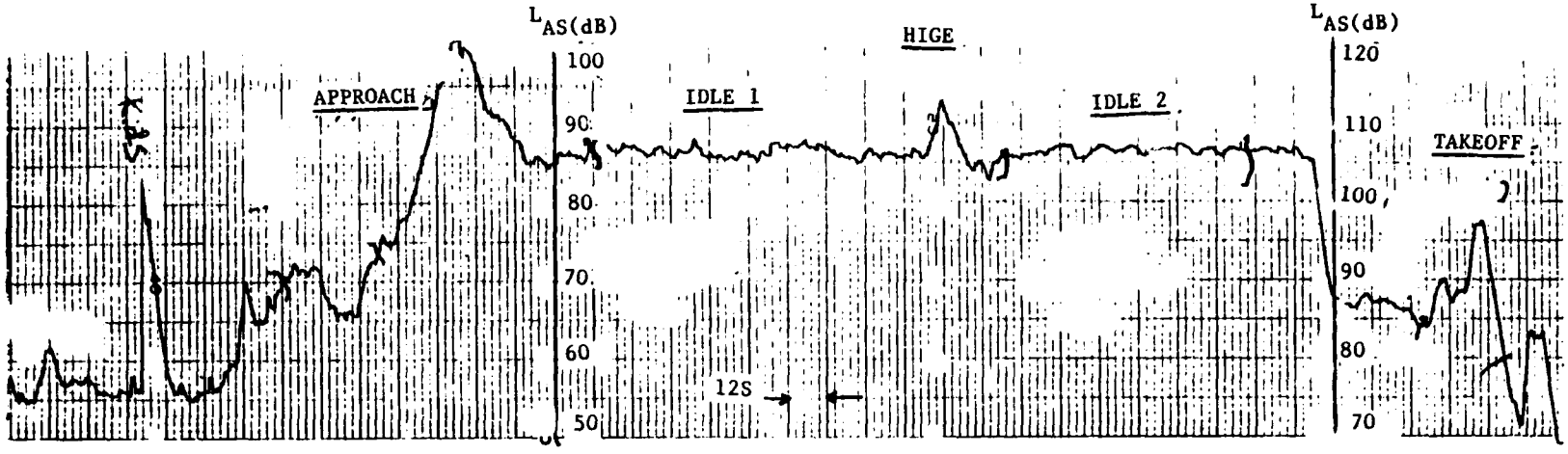
HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted Equivalent Sound Level

TABLE B4

INFLUENCE OF HELICOPTER OPERATIONS ON
AMBIENT SOUND LEVELS

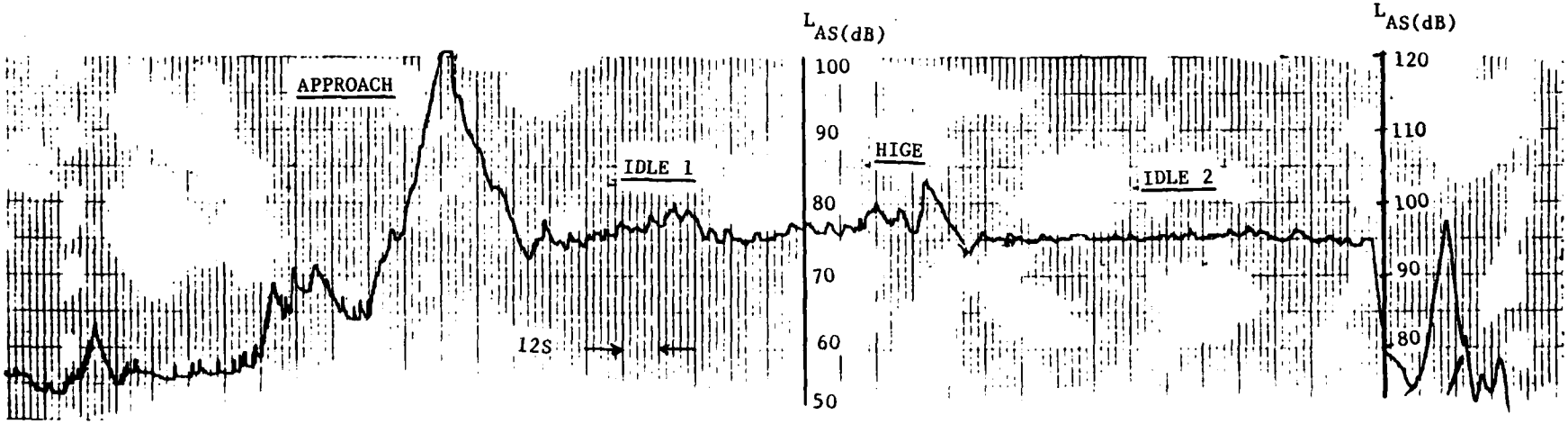
L(min)	47	48	52
L(99)	48	49	53
L(90)	53	52	56
L(50)	60	56	60
L(10)	75	86	63
L(1)	77	94	70
L(.1)	80	103	72
L(max)	81	104	73
L(EQ)	68	83	61
SAMPLE LENGTH	30 min	30 min	30 min
DATE	8/13/82	8/13/82	8/13/82
SAMPLE PERIOD	8:24-8:54 am	9:59-10:29 am	10:35-11:05 am
NOISE SOURCES	AMBIENT + BLOW-IN INSULATION TRUCK	AMBIENT + ALOUETTE III OPERATIONS	AMBIENT
LOCATION	SITE 3-ST. LUKE	SITE 1-ST. LUKE	SITE 1-ST. LUKE
COMMENT			



SITE 1

Alouette III/Site 1
St. Luke Hospital/Aug 13, 1982

FIGURE 2



Alouette III/Site 2
St. Luke Hospital/Aug 13, 1982

APPENDIX C: SA-350 ASTAR

Doctors Hospital

Table C1: Presents single event helicopter data

Table C2: Displays the influence of an ASTAR operation cycle on ambient sound levels

Figure C1: Provides a noise level time-history of the helicopter operation cycle

St. Luke Hospital

Table C3: Presents single event helicopter data

Figure C2: Provides a noise level time-history of the helicopter operation cycle

TABLE C1

FAA HELICOPTER NOISE SURVEY

Helicopter: SA-350 ASTAR Test Date: 8/13/82

Location: Doctors Hospital

Test Time: 12:20 pm MST Met: 91°F, 61% RH

Site	Distance from Center of Pad	Approach Noise Units Are Decibels (dB)		Takeoff Noise Units Are Decibels (dB)		Decibels dB		
		L_{AE}	L_{ASm}	L_{AE}	L_{ASm}	L_{Aeq} I_1	L_{ASm} HIGE	L_{Aeq} I_2
1	129	107	99.4	103.3	93.6	73.1	90	78.1
2	242	102.9	93.6	99.6	91.4	64.9	85	69.4
3	404	-	87	-	86	56	68	58

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow-Response maximum Sound Level

I_1: Idle mode 1, fuselage parallel to measurement array

I_2: Idle mode 2, fuselage perpendicular to measurement array

HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted Equivalent Sound Level

TABLE C2

INFLUENCE OF HELICOPTER OPERATIONS
AMBIENT SOUND LEVELS

L(min)	46	45	44
L(99)	48	47	45
L(90)	51	50	48
L(50)	55	57	53
L(10)	63	67	61
L(1)	73	83	75
L(.1)	77	87	81
L(max)	78	87	83
L(EQ)	61	68	62
SAMPLE LENGTH	30 min	30 min	30 min
DATE	8/13/82	8/13/82	8/13/82
SAMPLE PERIOD	11:30am-12 pm	12 pm-12:30pm	12:30 pm-1:00 pm
NOISE SOURCES	AMBIENT	AMBIENT + SA-350 OPERATIONS	AMBIENT
LOCATION	DOCTORS HOSPITAL SITE 3, 404 ft from center of pad	SAME	SAME
COMMENT			

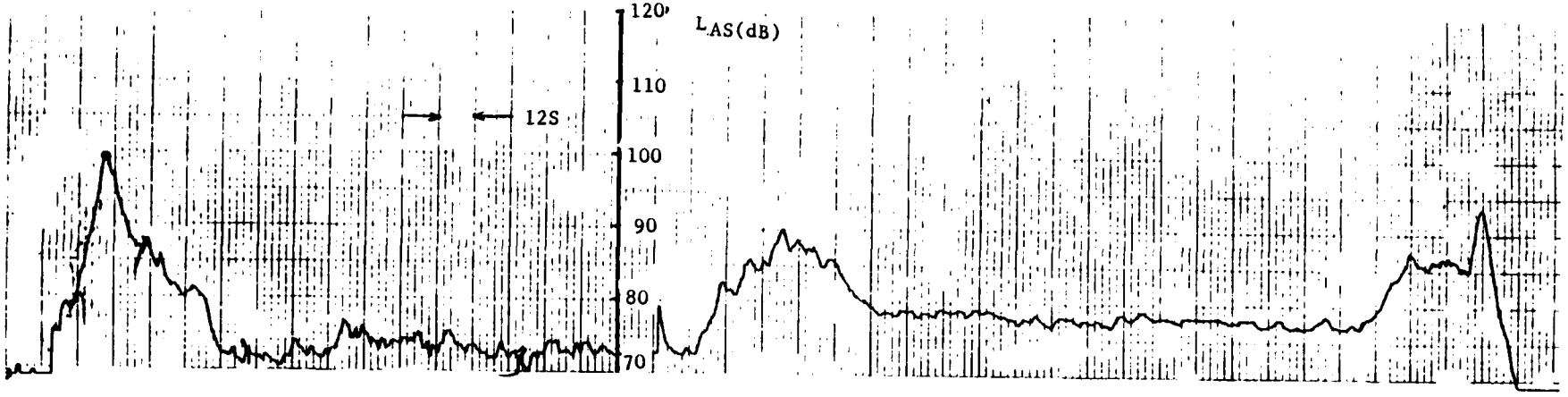
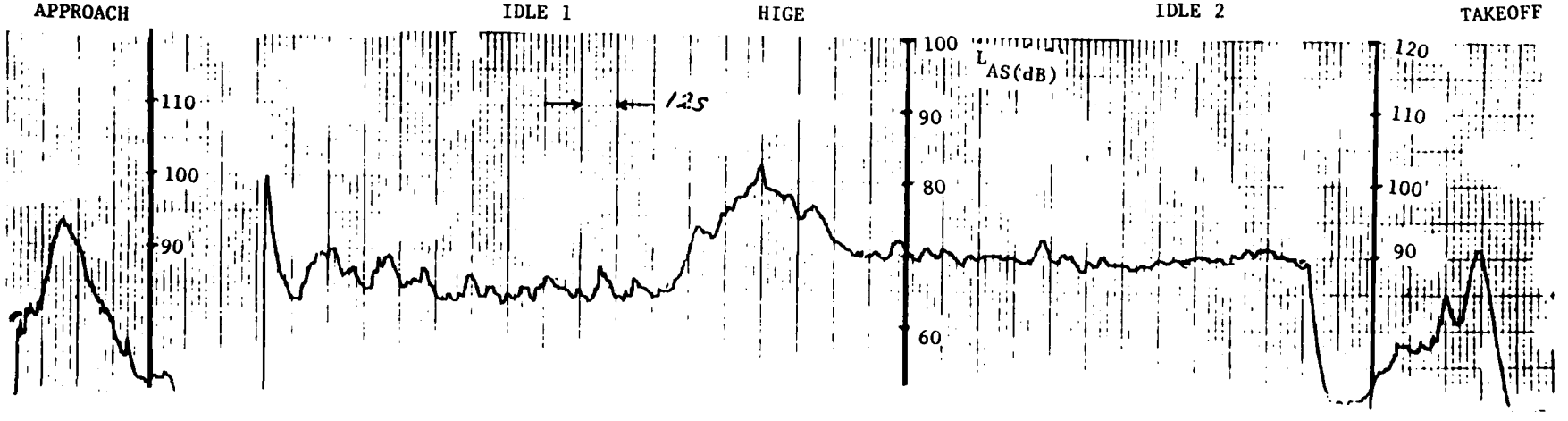


FIGURE C1

ASTAR 350/Site 1
Doctors Hospital/Aug 13, 1982



ASTAR 350/Site 2
Doctors Hospital/Aug 13, 1982

TABLE C3

FAA HELICOPTER NOISE SURVEY

Helicopter: SA-350 A-Star Test Date: 8/13/82

Location: St. Luke Hospital Phoenix Arizona

Test Time: 9:30 am MST Met: 82°F, 72% RH

Site	Distance from Center of Pad	Approach Noise Units Are Decibels (dB)		Takeoff		Decibels dB		
		L_{AE}	L_{ASm}	L_{AE}	L_{ASm}	L_{Aeq}	L_{ASm}	L_{Aeq}
						I_1	HIGE	I_2
1	145 ft	107	97.5	102.4	92.5	74	90	75
2	280 ft	-	93	-	89.5	62	78	64
3	435 ft	-	90	-	88	HIGH AMBIENT		

Definitions:

L_{AE}: A-Weighted Sound Exposure Level

L_{ASm}: A-Weighted Slow-Response maximum Sound Level

I_1: Idle mode 1, fuselage parallel to measurement array (nose away)

I_2: Idle mode 2, fuselage perpendicular to measurement array

HIGE: Hover In Ground Effect

L_{Aeq}: A-Weighted Equivalent Sound Level

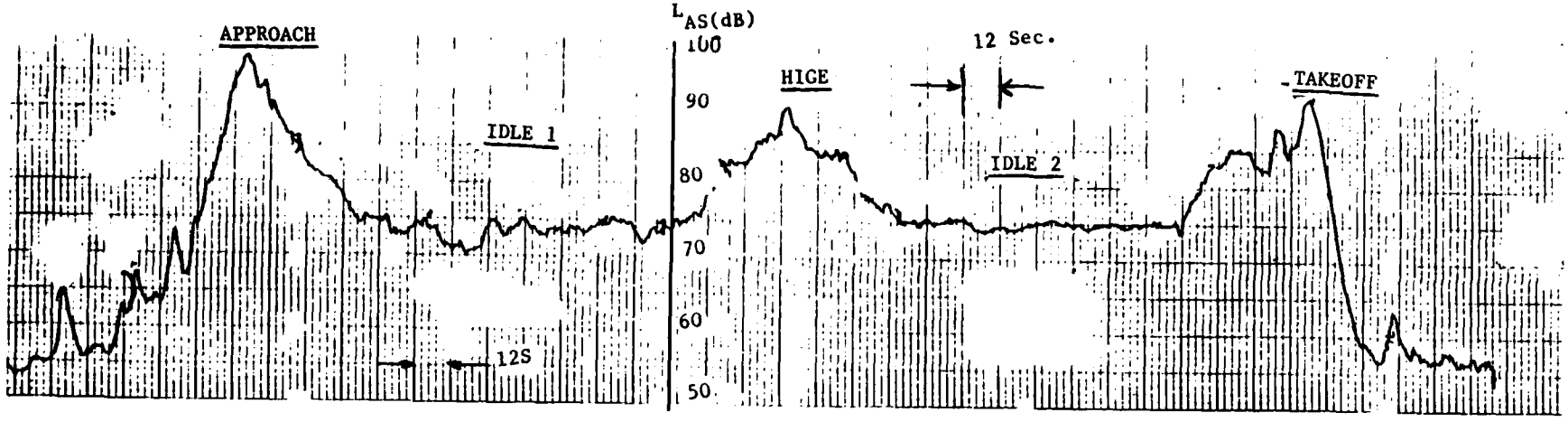
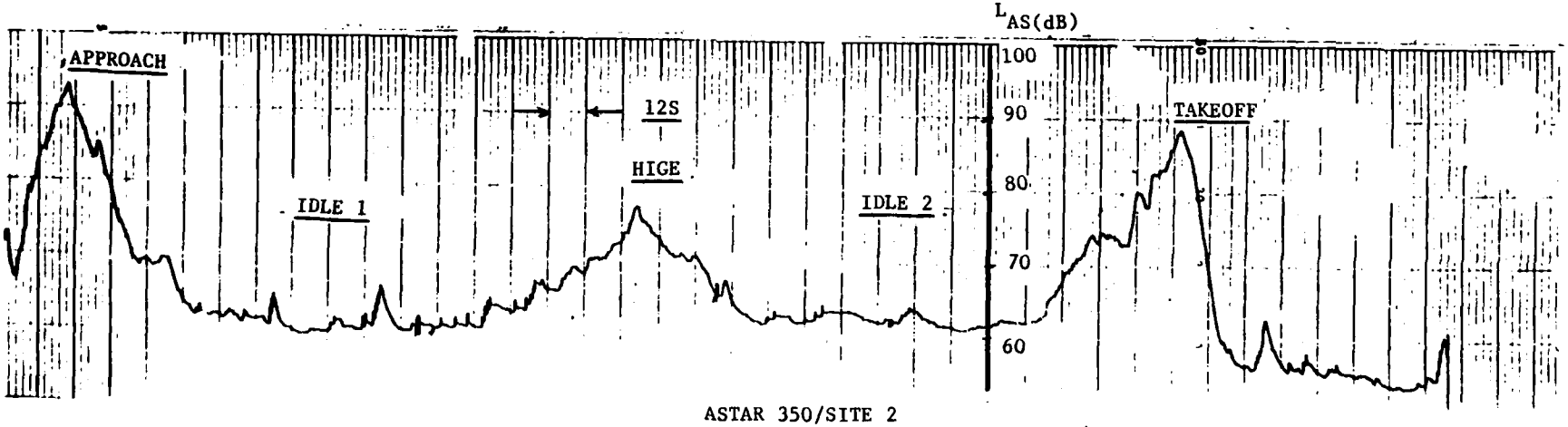
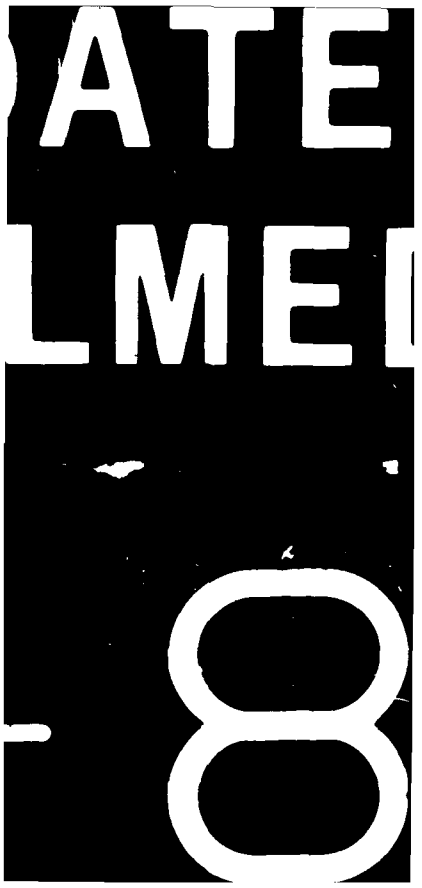


FIGURE C2

ASTAR 350/Site 1
St. Luke Hospital/Aug 13, 1982



ASTAR 350/SITE 2
St. Luke Hospital/Aug 13, 1982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